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Docket No. TI-36211

TIP484US



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re **PATENT** application of:

Applicant: Rajesh Tiwari et al.

Application No.: 10/663,948

For: DUAL DEPTH TRENCH TERMINATION METHOD FOR
IMPROVING CU-BASED INTERCONNECT INTEGRITY

Filing Date: September 16, 2003

Examiner: Phat X. CAO

Art Unit: 2814

REPLY BRIEF

**Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450**

Dear Sir:

Applicants submit this brief in connection with the appeal of the above-identified case and in response to the Examiner's Answer dated August 1, 2006.

REMARKS:

A. REJECTION OF CLAIMS 1, 2, 4 AND 9 UNDER 35 U.S.C. § 103(a)

Claims 1, 2, 4 and 9 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,433,432 (Shimizu) in view of U.S. Patent Application No. 10/454,667, Publication No. 2003/0227089 (Watanabe et al.). Reversal of the rejection is respectfully requested for at least the following reasons.

Applicants respectfully resubmit their arguments in support of patentability provided in the reply brief filed on May 15, 2006.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must *teach or suggest* all the claim limitations.

The cited references *fail to teach or suggest* all of the claim limitations of claims 1-2, 4 and 9 for at least the reasons below and, therefore, a *prima facie* case of obviousness has not been established and this rejection should be reversed. Applicants show *infra* that Shimizu and Watanabe et al., alone or in combination, fail to teach or suggest forming a trench with a *minimum* length between the trench edge and the closest via edge.

Claim 1 includes forming a trench with a first edge in said low K dielectric layer over said plurality of vias wherein said trench extends a *minimum length* beyond the edge α of a via closest to the first edge of said trench, which is not taught or suggested by the cited references.

Generally, Shimizu discloses a semiconductor device having a fluorine insulating film and reduced fluorine at interconnection interfaces. The device allegedly prevents the problem of plugs being peeled off from an upper surface of the wiring layer after the protection insulating film is formed. The device of Shimizu maintains a good connection (adhesion) between a metal film buried in a trench of a fluorine containing

insulating film and another metal film connected to such metal film. (Column 2, lines 19-24). Shimizu attempts to reduce the amount of fluorine on the surface of the metal film buried in the trench so as to improve the adhesiveness between the metal film and the metal plugs or the metal film and the overlying fluorine-noncontaining insulating film. (Column 2, lines 43-50)

The Examiner's Answer of August 1, 2006 does admit that Shimizu fails to disclose forming a trench extending a minimum length of 0.2 μm . However, the Examiner's Answer maintains that Shimizu teaches forming a trench extending a minimum length, with which Applicants respectfully disagree. The Examiner's Answer of August 1, 2006 erroneously relies upon item 12b of Shimizu to teach the minimum length between the trench edge and the closest via, as recited in claim 1. Item 12b of Shimizu is a pad trench 12b formed in an upper area of a second SiOF film 12, formed by patterning the second SiOF film 12. (Column 5, lines 37-41). It is conceded that Shimizu does show a distance from an outer edge of the pad trench 12b to a via 12a, but the distance is incidental and no teaching is provided in Shimizu of a distance from trench to via that must exceed some predetermined value as recited in claim 1.

The Examiner's Answer of August 1, 2006 also erroneously asserts that Shimizu teaches such a minimum length so as to participate in preventing peeling-off of plugs from metal wirings. It is respectfully submitted that the above assertion is incorrect. Shimizu employs a sputter to etch the surface of the copper wiring 10 *via* the holes 12a *to remove an oxide film* formed on the surface of the copper wiring 10. (Column 5, lines 45 to 48). As a result of the sputter, shoulder portions of the second SiOF film 12 around the holes 12a are obliquely scraped off to expand a diameter of the holes 12a in the neighborhood of the pad trench 12b. (Column 5, lines 49-52). ***The oblique scraping of the shoulder portions is merely a result of the sputter etch to remove the oxide film from the surface of the copper wiring and not to have a minimum length as in claim 1.*** Shimizu does not teach or suggest that the obliquely scraped shoulder portions participate in adhering the metal plugs. Instead, Shimizu clearly states that the peeling off of the copper wiring 10 is prevented by sputtering of the copper wiring 10 and then exposing to the ammonia plasma or polishing the copper film 10 using a slurry after the copper wiring is formed. (Column 8, lines 43-53). Therefore,

Shimizu does not need a minimum length from a trench edge to a via edge in order to form a shoulder portion. Accordingly, a minimum length from the trench edge to the via edge is not taught by Shimizu expressly or inherently as recited in claim 1.

The Examiner's Answer of August 1, 2006 is apparently assuming that a shoulder portion between the closest hole and edge of the pad trench 12b is required thereby establishing a minimum distance. However, such a distance in the example of Shimizu or otherwise does not establish *forming* a trench with a minimum length from trench edge to via edge.

The Advisory Action of November 28 simply dismisses Applicant's above argument by suggesting that Figs. 3H and 3I of Shimizu include a scraping portion and a planar portion formed between the trench edge and the via edge. Figs. 3H and 3I of Shimizu *do suggest a distance between a trench edge and an edge of a via*, but this is not sufficient to teach *a method of forming a copper interconnect layer including forming a trench that extends a minimum length of 0.2 μm beyond the edge α of a via closest to the first edge of said trench* as in claim 1.

It is noted that the Office Action of September 9, 2006 suggests that the scraping off of the shoulders participates in preventing the peeling off of the plugs from the metal wirings. Applicants respectfully disagree. As shown above, Shimizu relies on adhesion between the copper wiring and the overlying plugs and film in order to prevent peeling. The sputter is performed to remove fluorine from the surface of the copper wiring 10 and the shoulder formation is merely an unintended by-product thereof. (Column 8, lines 43-53, and, for example Figs. 5, 6, 12, and 13). Therefore Shimizu fails to teach or suggest the above highlighted feature.

Watanabe et al. also fail to teach a minimum length.

The Examiner's Answer of August 1, 2006 suggests that Watanabe et al. teach a minimum length, however, it does not. Watanabe et al. merely provide dimension examples of various wiring patterns and width patterns (Paragraph 175) and does not teach or suggest a *minimum* length between a via edge and a trench edge.

Claims 2 and 4 depend from claim 1 and are, therefore, not taught by Shimizu and Watanabe et al., ***alone or in combination***, for the above reasons. Additionally, claim 9 also recites the minimum length between the trench edge and the closest via and is also not taught by Shimizu and Watanabe et al., alone or in combination, for the above reasons.

The Examiner, in the Examiner's answer dated August 1, 2006, still fails to show that Shimizu and Watanabe et al. alone or in combination, teach or suggest forming a trench that extends *a minimum length* beyond the edge α of a via closest to the first edge of said trench. The Examiner is reminded that the prior art reference (or references when combined) must teach or suggest all the claim limitations. In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Therefore claims 1, 2, 4 and 9 are non-obvious over the cited art. Accordingly, withdrawal of the rejection of claims 1, 2, 4 and 9 is requested.

B. CONCLUSION

For at least the above reasons, the claims currently under consideration are believed to be patentable over the cited references. Accordingly, it is respectfully requested that the rejections of the pending claims be reversed.

For any extra fees or any underpayment of fees for filing of this Brief, the Commissioner is hereby authorized to charge the Deposit Account Number 20-0668, TI-36211.

Respectfully submitted,
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CERTIFICATE OF MAILING (37 CFR 1.8a)

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop Appeal Brief - Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Date: September 27, 2006


Christine Gillroy